The Influence of Precipitation Fluctuation on the Farmers' Land Use Behaviors in Farming-grazing Transitional Zone
Taking Ejin Horo Banner in Inner Mongolia of China as a Case

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1. Abstract

The precipitation fluctuation is basic characteristic in the semiarid area of northern China, which made this area became farming-grazing transitional zone in the past. The precipitation fluctuation has seriously impacted the land productivity to a great extent, which has also caused an array of land-use and ecological problems. This paper took Ejin Horo Banner in Inner Mongolia of China as a case, to analyze the impact of precipitation variation on farmers' utilization of cultivated land, grass land and woodland, by interviewing the local farmers and using local statistic data. The results showed that, in order to counteract the fluctuation of precipitation, the farmers dig wells to irrigate cultivated land; in order to prevent the grassland degradation, the farmers grew grass and prohibited over grazing； in order to combating wind erosion and obtain good products, the farmers planted suitable shrubs. Farmers took suitable land use pattern for adapting precipitation fluctuation.

2. Introduction

The farming-grazing transitional zone, located in the semiarid area of northern China, has an array of the ecological problems. This problem is caused by natural environment, especially the precipitation fluctuation and the man-land relationship. The frequent precipitation fluctuation resulted in the fluctuation of productivity. Because of this fluctuation, the land was suitable to crop plantation in one period, while suitable to stockbreeding in another period. For adapting this fluctuation, the farmers have to select suitable land use pattern to resolve the contradiction between the ecological fragility of land use and the rigid demand of farmers' living necessity.

The strong relationships between precipitation fluctuation and land use have been well documented in many case studies(Nicholson, et al.,1994; Shi,1989; Zhou et al, 1991; Sun et al, 2000; Fan et al., 2005).

This paper illustrated farmer's land use behaviors for responding the precipitation fluctuation impact on the land productivity.

3. Study Area

Ejin Horo Banner (E108º58′-E101º25′; N38º56′-N39º49′) is located in the Erodes Plateau, northern China, which covers 5600 square kilometers, and the population is 143.7 thousand. In the east, it is hilly and gully region, the main sediment is loess. In the west part, it is somewhat flat terrain that the bedrock is sandstone dominant. The bedrock is not very consolidated. So the rocks weather easily.

3.1 Climate

The annual rainfall is 358mm, the evaporation is 2535mm, and the humidity is 0.29-0.37. There is 7 years drought in 10 years. Therefore, the agricultural production is not stable. Wind often happens and is strong,

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especially in winter and spring seasons. The sandy texture of soils is easily eroded. So, this is an area that desertification easily happen. Sandstorm is over 26 days in a year. The sand is not come from outside, it is originated locally.

3.2 Vegetation and land use

Hundreds years ago, the whole region covered with grass that annual grass were dominant, and it was sheep's heaven. In those days, nomads grazed their sheep and cattle roamed in the vast steppe. The desertification was not a problem in those days.

The cultivation began in 1697. At the end of Qing dynasty (1911)，nearly all of the land suitable to farm was plowed. In 1949, there were 82133 ha. farmland, occupying 13.73% of the total land. Since the establishing of PRC, cultivation has been taking as an important task, because more and more people need food supply. Especially there were three periods of big cultivation; they were 1955-1956, 1958-1962, 1070-1973.

With long historical influence of climate change and man's disturbance, biennial or perennial shrubs and mugwort substitute the annual grass. Now, the perennial grass are dominant, perennial shrubs and semi-shrubs distribute widely. All of the woods are man made; there is not any natural forest. The woods mainly are poplar and willow Shrubs, most of them are also reforested. The main purpose of reforestation is preventing wind erosion as windbreak. The grassland degraded, and its biomass is low and the quality is not good either.

Being scared of starvation, people grow crops as possible as they can for storing food in case of drought years. Farmland mainly distributes on the flat terrain and in the river valley. The main crops are grain, including corn and millet.

3.3 Desertification

With cultivation of marginal land, soil erosion is getting severer and severer. Overgrazing also causes grassland degraded. Before 1974, in a word, desertification developed so severe that the production of agriculture, even stockbreeding, were greatly influenced.

4. Methodology

Method of farmer interview and local statistic data were employed in this paper. 151 farmers were interviewed for investigating their land use types, products, income, etc. We put the farmer interview data and local statistic data into Excel for analyzing.

5. Results

5.1 The climate influence on cultivated land use

The correlation analysis between the annual precipitation and grain yield per unit from 1959 to 2005 in Ejin Horo Banner indicated that when precipitation influenced crop's growing obviously, the fluctuation range of grain output was bigger than precipitation fluctuation; while non-precipitation factors influenced crop's growing obviously, the fluctuation range of grain output was less than precipitation fluctuation. The amount of precipitation had obvious effect on grain output during these 47 years. The relationship between precipitation and grain output made farmers grow crops as possible as they can, hope to meet a much precipitation year and obtain good harvest, and to store grain standing against drought years. So farmers cultivated land extensively. Because the soil was infertile, so farmers had to abandon the cultivated land with less fertility and came back grassland for fertility recover, which resulted in excessive reclamation，fallow and desertification.

In 1970s, traditional agriculture had been reformed; the collective owned cultivated land was allocated to individual farm households on the basis of family size. Farmers, who gained the right to cultivate and manage their land, were encouraged to improve the irrigating condition which is greatly restricted the grain yield in this

area. It is shown that to develop shallow wells is the farmers' feedback to minimize the drought (Figture1). Farmers dig much wells in the late 1970s; more and more farmers dig wells in 90s. In the late 90s, the reaction of digging well was simultaneous with drought. However the number of wells became less in 2002, it is due to the rich precipitation and the constructions from the last 3 years. Generally, while the precipitation increased, the number of wells became less compared the past; while the precipitation decreased, the number of wells became more compared the past.

126 families in 151samples had 147 shallow wells and 32 deep wells, which means 1.42 wells per family. In response to the precipitation fluctuation, farmers dig wells for adoption, which made the grain yield stable and higher. That prevented farmers cultivating sandy land at random.

5.2 The climate influence on grassland use

Grass is much tolerant to drought than crops. So, pasture can attain product much or less, if the trophosome/leave start growing, even in dry year. Therefore, the climate has less impact on grass than crops. However, the yield of grass is still affected by climate. In 1998, the prohibiting grazing policy was carried out and man-made grass was encouraged in Ejin Horo Banner. The main purpose was to improve grassland quality and fight back the grass production variability. During these ten years the policy carried out, although the grass ecosystem has been improved some what, the grass yield is still fluctuated in relation to the amount of precipitation, but the general fluctuation of grass yield was in a higher level.

The main land cover in Ejin Horo Banner is degenerating grassland, which has sparse brushwood and short

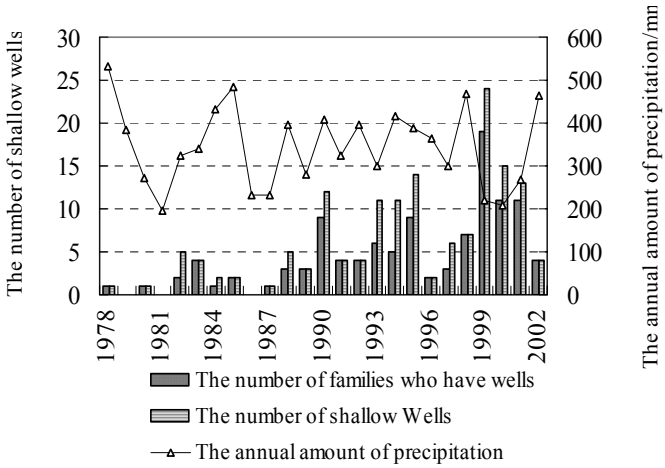

Figure 1 The relation between the number of families who have wells and the annual amount of precipitation

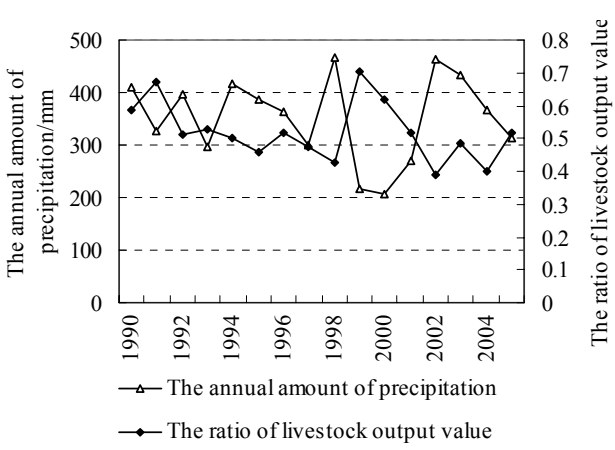

Figure 2 The relation between the ratio of livestock output and the annual amount of precipitation

grass, so it can not be mowed but can be grazed. Therefore, the stockbreeding fluctuated either. The livestock population had a negative relation with the annual amount of precipitation (R1=-0.6661) (Figture2). When the precipitation and forage were abundant, farmers chose to keep the livestock; amount of livestock was low in the market. Once a dry year fell, and forage was in shortage, farmers had to sell or butcher livestock so that the amount of livestock in the market was increasing. It means that livestock breeding was supplement of crop production in dry year by selling livestock.

5.3 The climate influence on woodland use

As trees have a deep root system, they can get water from deeper soil, even groundwater, so the precipitation fluctuation affects less on trees than both herbage and crops. Trees also need a large amount of water for evapotranspiration. According to the investigation of Na (1997), continuum drought were happened from 1999 to

2001 in Ejin Horo Banner, which made trees died largely. Most farmers estimated that the mortality rate of trees in ridge land reached 20~40%, and in bottomland reached 0~30%; while the mortality rate of shrubbery in ridge land reached 10~20%, and in bottomland reached 0~10%. So the forestation had to face the impact of climate fluctuation in Ejin Horo Banner. Most farmers planted fast-growing wood, such as poplar, to gain benefit steadily and fast. In addition, they plant Salix matsudana, Salix linearistipulares, Tamarix chinensis to decrease risk caused by climate. Salix matsudana in Ejin Horo Banner can be cut in 5 to 7 years, and get willow beams, branches and leaves; Salix linearistipulares, Tamarix chinensis can be cut in 3 to 5 years, and its branches and leaves can weave handicrafts, baskets; those branches and leaves can be sold to flake board factory through simple process. This made farmer get income in shorten period and reduce cost as well (Table1).

Table 1 The reforestation states in different period Unit: ha

Forest Category	Poplar Woodland	Salix matsudana	Tamarix chinensis	Total
during the collective owned period(before 1980)	14.43	62.62	71.93	148.98
after collective owned period (1980-2002)	88.47	106.87	271.67	467.01
The growth rate(/%)	613.09	170.66	377.69	313.47

6. Conclusion

(1)The fluctuating precipitation has great influence on grain yield per unit area, which made farmers cultivating extensively, wishing have good harvest in the year with sufficient rainfall to supported poor harvest in drought year. Farmers dig wells to irrigate land, so the grain yield per unit area was increased, and cultivated land was decreased and stabilized, as well as released the negative influence of over cultivation on ecosystem.

(2)The grass yield was also influenced by annual precipitation fluctuation, and the output of livestock fluctuated with it. Through reducing livestock number, the pressure on grassland was released in traditional stockbreeding way. In recent 10 years, the grass yield is increased by improving and prohibiting grazing. The conflict between farmers' need of the stability of livestock and the fluctuation of grass yield was still a threat to sustainable utilization of grassland.

(3)The influence of precipitation on grass and crops was more obvious than on the trees. However, the woodland's total demand for the amount of precipitation was higher than farmland and grassland. The woodland area is largely increased after the collectivism period. For counteracting drought, Farmers planted shrubs that need less amount of water and are tolerant drought than trees.

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